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Indian Standard

GENERAL REQUIREMENTS FOR OPTICAL INSTRUMENTS

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6 ***September* 1964**

Indian Standard
GENERAL REQUIREMENTS FOR OPTICAL INSTRUMENTS

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Indian Standard

GENERAL REQUIREMENTS FOR OPTICAL INSTRUMENTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 20 June 1964, after the draft finalized by the Optical and Mathematical Instruments Sectional Committee had been approved by the Engineering Division Council.

0.2 A variety of optical instruments is used on a large scale by the industry and a number of other establishments. Their requirements as regards the quality of material, workmanship and finish, precision and performance characteristics vary according to their field of application. In view of these considerations, although it would appear to be impracticable to lay down a common standard for all types of optical instruments, it is still possible to specify the more general requirements which should invariably be satisfied by the different types of instruments. Such requirements as are specific to the functional characteristics of the instruments are not covered by this standard but are only referred to in some cases. For these special requirements, reference should be made to the relevant standards.

0.3 In this specification, suitable methods for measurement of indicated parameters are given in the appendices. Other methods giving the same or higher accuracy may also be used.

0.4 As the general requirements dealt with in this standard are applicable to all types of optical instruments, this standard should be quoted as the basic standard of reference in all other specifications for optical instruments as far as the common requirements are concerned.

0.5 Taking into consideration the views of producers and consumers, the Sectional Committee responsible for the preparation of this standard felt that it should be related to the manufacturing practices followed in the country in this field.

0.6 The series of lens aperture markings and exposure time markings for still cameras specified in this standard are in conformity with those recommended in Draft ISO Recommendations No. 423 Exposure-Time Marking for Shutters Used in Still Cameras, and No. 424 Marking of Lens Apertures prepared by Technical Committee 42 Photography, of the International Organization for Standardization.

0.7 Wherever a reference to any Indian Standard appears in this standard, it shall be taken as a reference to the latest version of the standard.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960 Rules for Rounding Off Numerical Values (*Revised*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

0.9 This standard is intended chiefly to cover the general technical provisions relating to optical instruments, and it does not include all the necessary provisions of a contract.

---

1. SCOPE

1.1 This standard prescribes the general requirements and methods of test for optical instruments, such as telescopes, microscopes, still cameras and still projectors. For requirements of any particular instrument, reference should be made to the relevant specification for that instrument.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 1399-1959 Glossary of Terms Used in Optical Technology shall apply.

3. GENERAL REQUIREMENTS

3.0 Optical instruments shall conform to the following general requirements.

3.1 Materials

3.1.1 The materials used shall conform to the requirements of IS : 988-1959 General Requirements for Optical Components, and IS : 1400-1960 Specification for Optical Glass.

3.1.2 When filters are provided, they shall be of good optical quality and of suitable transmission characteristics.

3.1.3 All materials used in the manufacture of the instrument shall suit their particular purpose and be capable of maintaining all their essential properties during use, transit and storage.

3.1.4 The materials used in the manufacture of the mechanical components shall be uniform in quality and free from impurities, flaws and any other defects likely to impair their performance.

3.1.5 Sheets or strips used for spinning or drawing shall be of such quality that after the respective operation the material may be so finished as to present a good smooth surface.

3.1.6 Tubing, where used, shall be uniform in quality and condition, and shall be sound, smooth, free from irregularities and other defects likely to impair their performance.

3.1.7 Materials likely to deteriorate rapidly under normal climatic conditions shall be avoided as far as possible.

3.1.8 The materials used shall be such that they shall not deteriorate when the instrument is tested to assess its durability for use under applicable climatic and environmental conditions in accordance with IS : 2352-1963 Procedure for Basic Climatic and Durability Tests for Optical Instruments.

3.1.9 Lubricants, greases, lutings, cements and paints used for the equipment shall be suitable for the temperature conditions likely to be encountered in normal use. Their properties shall conform to the requirements stipulated in the relevant specifications.

3.2 Construction

3.2.1 The mechanical construction of the instruments shall have adequate robustness. It shall provide stability during use and smooth operation of moving parts.

3.2.2 The mechanical components shall be free from all defects likely to impair performance.

3.2.3 Interchangeability of parts which are liable to wear in use or damage shall be ensured.

3.2.4 For the external finish of optical instruments either stoving paints, or chemical or electrical surface treatments shall be adopted. Brushing paints shall not be used for the purpose.

3.2.5 The internal surfaces of mechanical components shall be finished dull black to avoid stray reflection of light from such surfaces leading to reduced contrast in the image.

3.2.6 Wherever possible, the design shall provide for tropicalization to afford protection against filming, fogging and fungus growth on optical components which may cause deterioration of the optical performance. To this end, hermetic sealing of the instrument and the provision of a desiccant like silica gel within the instrument is recommended to be incorporated.

3.2.7 To avoid loss of light by reflection at glass-air surfaces, the coating of lens surfaces with an anti-reflection film (hard blooming) is recommended. The quality of the coated film should satisfy the requirements stated in IS : 988-1959 General Requirements for Optical Components.

3.3 Workmanship

3.3.1 Workmanship shall be of the highest grade in instrument manufacturing practice, commensurate with the intended use of the instrument in question.

3.3.2 All optical components shall conform to the requirements in respect of workmanship, surface finish, centring, edging, chamfering, silvering, blooming, cementing and optical characteristics as stipulated in IS : 988-1959. They shall also be free from any inherent or induced strain.

3.3.3 All optical surfaces shall be perfectly clean and free from water marks, fungus stains, dust, grease or dirt. The mechanical components shall be clean and free from deposits of dirt or dust which may affect their own functioning apart from the possible transfer of these deposits to optical surfaces.

3.3.4 The assembly of optical instruments shall be done under dust free conditions and controlled humidity.

3.3.5 In the case of tropicalized instruments, the interior of the instruments shall be desiccated and fumigated during assembly before the instruments are finally sealed, to minimise the risk of damage due to fungus growth.

3.4 Functional Requirements

3.4.1 The alignments of the optical axis and the mechanical axis are important characteristics in every optical instrument; the applicable tolerances should be as specified in the relevant specifications. It shall be ensured that such alignment renders the system free from errors of collimation within the limits specified in the relevant standard.

3.4.2 All moving parts shall function after assembly without undue stiffness, looseness or backlash.

3.4.3 Stray light causing a veiling glare in the image shall be reduced to a minimum. A method for determining the veiling glare is given in Appendix A.

3.4.4 The axial light transmission of the optical system shall be adequate for the intended use of the instrument and shall in no case be less than 95 percent of the stated value. A method for determination of the para-axial transmission factor of a telescope is given in Appendix B.

3.4.5 Leakproofness of the instrument shall be tested in the case of fully tropicalized instruments by forcing air to build up a pressure of 0·175 kgf/cm^2 in the instrument. The instrument shall be free from leakage for at least one minute.

3.4.6 When graticules, cross-wires or reference marks are provided, they shall be such as to appear sharp, clear and well-defined against the background. The width of the lines and the nature of the pattern shall not be such as to cause obstruction to the useful field of view.

3.4.7 Wherever required, the instrument shall be subjected to climatic and durability tests as laid down in the relevant specification for the instrument.

3.4.8 In instruments meant for special purposes, a suitable arrangement for night illumination of the graticule shall be provided. The illumination of the graticule shall be such as to bring out the pattern clearly against the background without being a distraction to the observer.

3.5 Stands and Cases

3.5.1 In cases where a stand is essential for use of the instrument, it shall invariably be supplied along with the instrument.

3.5.2 Carrying-cum-storage cases shall be provided with all instruments which may require to be carried from place to place in actual use. In the case of large instruments provided with a number of accessories, separate cases may preferably be provided for their storage.

4. OTHER REQUIREMENTS

4.0 In addition to the general requirements given under **3.1** to **3.5**, the following requirements for individual instruments shall be complied with.

4.1 Telescopes

4.1.1 The magnification of a telescope may be measured by the method given in Appendix C. The value obtained by measurement shall not differ from the specified value by more than 5 percent, unless otherwise stipulated.

4.1.2 The exit pupil of the telescope shall not normally be situated at a distance less than 6 mm from the surface of the eyepiece nearest to the eye.

4.1.3 A recommended value for the diameter of the exit pupils of telescopes intended for daylight observation is 4 mm.

4.1.4 The field of view of a telescope may be measured by the method given in Appendix D. The measured value shall not differ by more than 5 percent from the specified value.

4.1.5 The circles, lines and squares of a definition board of the type given in Appendix E, when viewed through the telescope, shall appear sharply defined, without any distortion and colour.

4.1.6 The resolving power of a telescope shall be measured by any of the usual methods. A recommended method is given in Appendix F. The measured value of resolving power shall not fall short of 80 percent of the theoretical resolving power of the telescope.

4.1.7 A vertical object when viewed through a prismatic telescope shall not appear inclined beyond 30 minutes to the vertical. A method of test is given in Appendix G.

4.1.8 When a dioptric scale is provided in the eyepiece of a telescope, the marked values of the scale shall not differ from the actual value at that position by more than $\pm\frac{1}{4}$ *D*, where *D* represents dioptre. For a fixed focus telescope the eyepiece shall be adjusted between $-\frac{1}{4}$ *D* and -1 *D*. A method of testing accuracy of the dioptric scale is given in Appendix H.

4.2 Microscopes

4.2.1 The magnification and numerical aperture NA of the objective shall be engraved on its mount, for example 40 × 0·65 NA.

4.2.1.1 In the case of oil immersion objectives, in addition to the marking specified in 4.2.1, the immersion characteristic shall be engraved, for example 80 × 1·3 NA Immersion.

4.2.1.2 The magnification shall also be engraved on the eyepiece, for example 10×.

4.2.2 The magnification of the objective shall be measured by the method given in Appendix J. The measured value of the magnification shall not differ from the specified value by more than 5 percent.

4.2.3 The numerical aperture of the objective shall be measured by an apertometer. The measured value of the numerical aperture shall not differ from the marked value by more than 5 percent.

4.2.4 The resolving power of the objective shall be measured by the method given in Appendix K. The measured value shall not be less than the theoretical value by more than 5 percent.

4.2.5 The magnification of the eyepiece shall be calculated by the formula $\frac{250}{f_e}$, where f_e is the measured focal length of the eyepiece in millimetres. This value shall not differ from the value marked on the eyepiece by more than 5 percent.

4.2.6 The following diatoms are recommended as test objects for judging the quality of definition and the resolving power of microscope objectives:

Navicula lyra for objectives of 16 mm focal length and over

Pleurosigma angulatum for objectives of 4 mm focal length

Amphipleura pellucida for objectives of 2 mm focal length

When observed under white light illumination, the image shall appear clear and well defined. The image shall be totally free from colour defects up to half the field of view and shall be reasonably free from colour up to two-thirds field of view.

4.2.7 The recommended mechanical tube length of the microscope is 160 mm nominal.

4.2.8 The optical and mechanical characteristics of each objective and eyepiece shall be so adjusted in the design that different objectives or eyepieces may be substituted one for another without any appreciable change in focus for the same make.

4.2.9 To facilitate interchangeability with objectives of different origin, the following screw threads shall be adopted:

Form	Whitworth
Major diameter	20·274 mm
Pitch	0·705 5 mm
Length of threads of objective	3·175 mm
Plain fitting above threads of objective	2·54 mm long, not to exceed 19·355 mm in diameter
Length of threads of nosepiece	Not less than 3·2 mm

4.2.10 To facilitate interchangeability, the nominal outer diameter of the eyepiece tube shall be 23·2 mm.

4.2.11 The microscope shall be provided with either a fixed stage, a rotatable stage, a mechanical stage or a combination of these. The mechanical stage, wherever provided, shall be graduated in millimetres and may be provided with a vernier. The movement of the mechanical stage shall be smooth and true. The surface of the stage shall be flat.

4.2.12 The microscope shall be provided with a device for both coarse and fine focussing except for small magnification objectives, where only coarse focussing is provided. The focussing devices shall be such that:

a) the focussing movement is smooth;

b) there is no appreciable backlash or movement of the body tube under gravity;

c) there is no lateral movement of the image during focussing;

d) for fine focussing, where provided, the movement is perfectly linear throughout the entire run when a scale for fine focussing is provided, that is, a division on the scale corresponds to the same focussing movement at any point in the range; and

e) the fine focussing arrangement shall have a mechanism which shall prevent damage to the slide when the objective comes in contact with it.

4.2.13 The microscope shall be provided with two mirrors, one plane and the other concave and/or a substage condenser for the purposes of illumination.

4.2.14 The numerical aperture of the substage condenser, wherever provided, shall be higher than the numerical aperture of the objectives.

4.3 Still Cameras

4.3.1 The general requirements of still cameras are covered in **4.3.2** to **4.3.15** and do not cover special requirements for different cameras, such as microfilming cameras, aerial cameras, etc.

4.3.2 The equivalent focal length in millimetre, the maximum aperture and the type and serial number, if any, shall be marked in sequence on the mounts of all camera lenses as given below:

50 mm *f*/2·8 Hind Anastigmat No. 12345, or
50 mm *f*/2·8 Anastigmat No. 12345

Where no serial number is to be quoted, the sequence shall be as follows:

50 mm *f*/2·8 Hind Anastigmat, or
50 mm *f*/2·8 Anastigmat

4.3.3 The equivalent focal length measured by any standard method or by the method given in Appendix L shall not differ from the marked value by more than 4 percent.

4.3.4 Every stop size other than the maximum aperture shall be chosen from the following series:

f/0·7, 1, 1·4, 2, 2·8, 4, 5·6, 8, 11, 16, 22, 32, 45, 64, 90 and 128

4.3.5 The value of the *f*-number for the maximum aperture as measured by the method given in Appendix M shall lie within ±5 percent of the marked value. The *f*-numbers corresponding to the different stop sizes shall also lie within ±5 percent of the marked value.

4.3.6 The distance markings shall be clearly indicated in metres and follow, as far as possible, the simple series *h*, *h*/2, *h*/3, *h*/4, etc, where *h* is the hyper-focal distance, every second or third term of the series being chosen wherever practicable. Infinity shall be indicated by the mathematical symbol ∞.

4.3.7 A depth-of-field scale to indicate the range of distances within which all objects located shall appear in focus, is recommended to be provided in still cameras.

4.3.8 The exposure time marking for a particular exposure setting of shutter shall be the reciprocal of the effective exposure time in seconds at the particular setting.

4.3.9 The exposure time markings shall be selected from the following series:

1, 2, 4, 8, 15, 30, 60, 125, 250, 500, 1 000 and 2 000

The highest speed marking need not however be selected from this series.

4.3.10 The front and the back frame of the camera shall be strictly parallel.

4.3.11 There shall be good agreement in register between the focussing screen and plate in the dark slide.

4.3.12 There shall be no stray reflection of light from the internal surfaces of the camera when tested in a dark room.

4.3.13 The camera shall be absolutely light-tight.

4.3.14 In all hand cameras, the design should provide for one or more precise view-finders to assist the user in locating the image. While the nature or the type of view-finder may be conditioned by the requirements in the design and construction of the camera, it is recommended that the field of view indicated in the view-finder should be slightly smaller than the field recorded on the film.

4.3.15 As a criterion for the quality of acceptable definition, the camera lens shall be judged by its resolving power. The resolving power shall be measured by using standard test charts of the Cobb type and expressed in lines per millimetre.

4.4 Still Film or Slide Projectors

4.4.1 In the choice of all parts and details of construction of a still projector, it is of primary importance to cater for the maximum structural strength and reliability under all operating conditions. The projector shall be of robust construction.

4.4.2 The equivalent focal length of the projection lens shall be determined by any of the standard methods. The measured value shall not depart by more than 2 percent of the marked value.

4.4.3 The lens shall be mounted in a suitable focussing mount. It shall be ensured that there is no shift in the image during focussing.

4.4.4 The image produced by the lens shall be clear and well-defined over the entire image area when viewed from a distance of twice the screen width across.

4.4.5 The optical axis of the projecting system shall be at right angles to the object plane as evidenced by good definition over the entire projected image on a screen placed at right angles to the same axis.

4.4.6 The resolving power shall not fall short of the required value stipulated in the relevant specification. It shall be tested by projecting a test chart of the type given in Appendix N.

4.4.7 The illumination of the object under projection shall be uniform. When there is a likelihood of the heat generated by the illuminating unit damaging the object or the projector components during prolonged use, a fan and heat absorbing filters shall be provided.

4.4.8 The illumination on the screen shall appear uniform and free from objectionable bands and patches. The illumination shall be measured at different points on the screen as given in Appendix P. The average illumination at the four corners shall not be less than 70 percent of the illumination at the centre.

4.4.9 The gate assembly of the projector should be easily removable as a unit without the use of tools. All parts should be easily accessible for cleaning.

4.4.10 The transport of the film or change of slide shall be smooth and cause no scratches or otherwise damage the film or slide.

5. PACKING AND PACKAGING

5.1 Optical instruments shall be securely packed for storage and transit so that there is no possibility of deterioration.

5.2 The description and number of contents shall be clearly marked on top of the package. The package shall also be marked with the symbol for fragile contents according to *IS : 1286-1958 Pictorial Markings for Handling Instructions for Non-Dangerous Goods, together with the legend HANDLE WITH CARE in red and also the symbol for RIGHT-WAY UP.

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*Since revised

APPENDIX A

(*Clause* 3.4.3)

METHOD OF MEASURING VEILING GLARE INDEX IN A TELESCOPE

A-1. DESCRIPTION

A-1.1 The veiling glare index may be measured by an apparâtus as shown in Fig. 1. The filament of a lamp *A* fitted in a suitable fixture *B*, is imaged by a large double condenser lens *C* in the plane of the collimator lens *D* whose focal plane is a few millimetres in front of the nearest surface of the condenser. A circular diaphragm *E* is placed in front of the condenser. The opening of the diaphragm is made to suit the instrument under test and is kept slightly more than the field of view of the instrument. An opaque blackened circular disc *F* subtending an angle of one degree at the collimator lens is supported on the axis of the condenser. The telescope under test is placed on a table *G* which may be so adjusted that the telescope is set co-axial with the collimator; in which position the disc *F* is seen at the centre of the field of the telescope. An iris diaphragm *H* is placed at the exit pupil of the telescope and a shutter *J* is set either to cover the aperture or leave it open. A selenium rectifier photocell *K* placed behind the iris diaphragm is connected to a galvanometer. The opening of the photocell is normally kept closed by a shutter *L*.

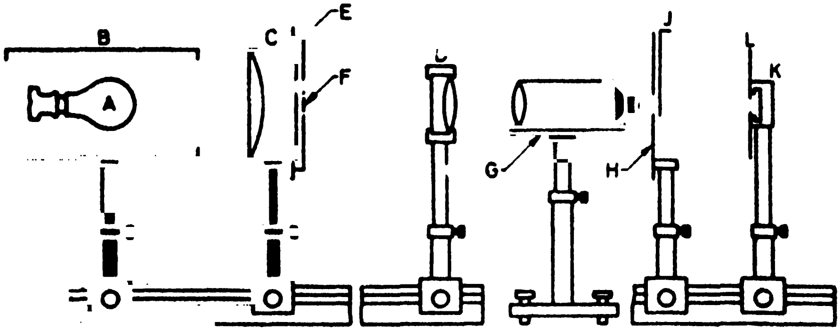


FIG. 1 APPARATUS FOR MEASUREMENT OF VEILING GLARE IN TELESCOPES

A-2. METHOD OF TEST

A-2.1 With the shutter *J* open, the eyepiece of the telescope is focussed to obtain a real image of the circular disc *F* on the aperture of the photocell, the position of which is adjusted until the diameter of the image is about 20 percent more than the cell aperture, the width of the overlap not being critical. With the shutter *J* closed and the galvanometer-photocell circuit closed, the galvanometer reading g_0 is noted. A second reading g_1 with the shutter *J* open is taken. The shutter is again closed and the disc *F* swung out of the field. Galvanometer readings with the shutter closed g_0' and open g_1' are again taken. The veiling glare index is given by the ratio:

$$g = \frac{g_1 - g_0}{g_1' - g_0'}$$

The values to be aimed at are 2 percent of the useful light for instruments having less than six glass-to-air surfaces and 3 percent of the useful light in instruments having more than six glass-to-air surfaces.

APPENDIX B

(*Clause* 3.4.4)

MEASUREMENT OF PARA-AXIAL TRANSMISSION FACTOR OF A TELESCOPE

B-1. Apparatus to measure the para-axial transmission factor is given below.

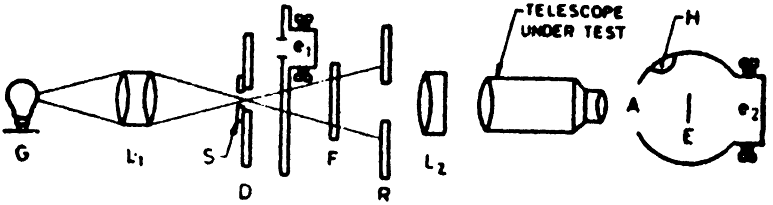


FIG. 2 APPARATUS FOR THE MEASUREMENT OF PARA-AXIAL TRANSMISSION FACTOR

B-1.1 An enlarged image of the filament of the 40-watt lamp *G* (*see* Fig. 2) is formed at a diaphragm *S*, by the condensing lens system L_1. Collimating lens L_2 is of about 250 mm focal length whose focus is situated at *S*. The diaphragm at *S* may consist of a set of small circular holes ranging from 0·5 to 2·5 mm in diameter, mounted in a slide. A rotating shutter *D* is located close to *S* and may snap into any one of the three positions. In position (1), it gives clear passage to the beam and in position (2) it totally cuts off the beam. In position (3), the light beam enters another aperture which is backed by a photocell e_1 connected in parallel with another photocell e_2 (to which reference is made later). A filter *F* is placed in the path of the beam to raise the colour temperature of the light to that of day light as well as to correct the spectral sensitivity of the photocell to that of the eye. The lens L_2 is fitted with an iris diaphragm to control the diameter of the beam entering the collimator. The telescope under test is mounted co-axially with L_2 such that the bright hole at the focal plane of L_2 may be seen through it at the centre of the field. The iris *R* may be closed down until the diameter of the emergent beam is well below the aperture of the telescope under test. Beyond the eyepiece of the telescope is mounted an integrating sphere of 15 cm diameter fitted with a rectifier photocell e_2. A circular disc *E*, about 2 cm in diameter is mounted by means of a thin supporting rod at the centre of the sphere. *H* is a lens having focal length of 75 mm used as an eyepiece to set the position of disc *E* and to see the light beam impinging on it. The interior of the sphere and both sides of *E* are nickel plated and thickly coated with magnesium oxide.

B-1.2 All the component parts of the apparatus are first aligned such that the emergent beam from the eyepiece of the telescope under test falls centrally on the disc *E*. The best arrangement would be the use of such an aperture at *S* as to make the beam enter *A* with a clearance of 2 to 3 mm all round and form a patch at *E* which leaves a margin of at least 5 mm.

B-1.3 After the adjustment has been completed, and with the lamp *G* switched on, the zero of the galvanometer is set by means of *D* at position (2). The readings d_1 and d_2 of the galvanometer shall be taken [with the shutter *D* in position (1)] with the light entering the integrating sphere once with the telescope and then without the telescope respectively. The transmission factor of the telescope is then given by $\frac{d_1}{d_2}$.

The photocell e_1 in combination with the third aperture is used only for checking the zero of the galvanometer without disturbing the set up, that is, as a reference.

B-1.4 As the time interval between the observations d_1 and d_2 may sometimes be considerable, the consistency of the incident light should be checked. This may be done just before and after every observation with the sphere by noting the galvanometer deflection d_3 using the photocell e_1. If the intensity changes, the current to the lamp may be adjusted to ensure the consistency of d_3.

APPENDIX C

(*Clause* 4.1.1)

METHOD OF DETERMINING THE MAGNIFICATION OF A TELESCOPE

C-1. The telescope is first illuminated by diffused light from the objective end. The diameter of the exit pupil is then measured by means of a travelling microscope placed at the eyepiece end.

C-2. The telescope is then illuminated from the eyepiece end and the diameter of the entrance pupil is similarly measured by a travelling microscope.

The magnification of the telescope is equal to diameter of entrance pupil divided by the diameter of exit pupil.

APPENDIX D

(*Clause* 4.1.4)

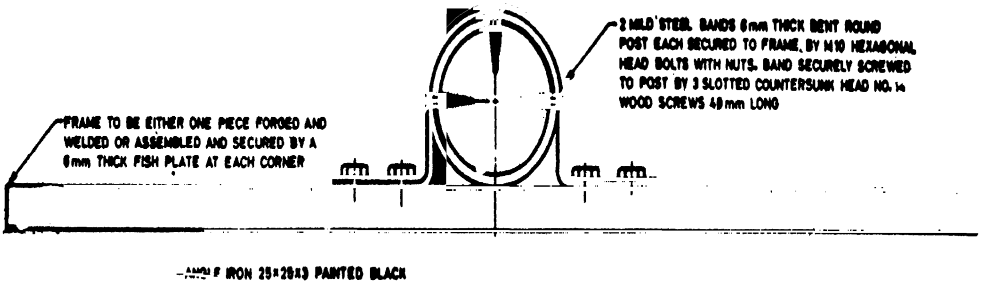
METHOD OF DETERMINING THE FIELD OF VIEW OF A TELESCOPE

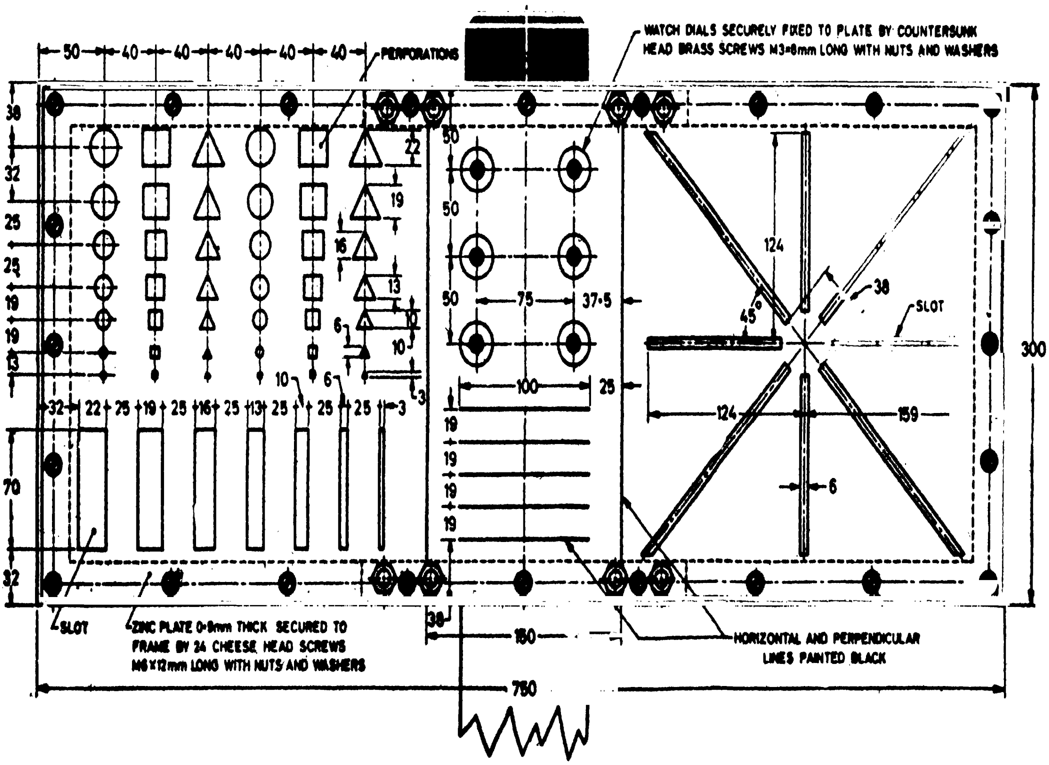
D-1. The telescope is mounted on a turn-table having an accurately divided circular scale. Any distant object is then brought into the field of the telescope first at one edge of the field and then at the opposite edge by turning the rotating table. The angle through which the table has been rotated gives the field of view of the telescope.

APPENDIX E

(*Clause* 4.1.5)

DEFINITION BOARD


2 MILD STEEL BANDS 6mm THICK BENT ROUND POST EACH SECURED TO FRAME, BY M10 HEXAGONAL HEAD BOLTS WITH NUTS. BAND SECURELY SCREWED TO POST BY 3 SLOTTED COUNTERSUNK HEAD NO. 14 WOOD SCREWS 40mm LONG
FRAME TO BE EITHER ONE PIECE FORGED AND WELDED OR ASSEMBLED AND SECURED BY A 6mm THICK FISH PLATE AT EACH CORNER
ANGLE IRON 25×25×3 PAINTED BLACK


50
40
40
40
40
40
PERFORATIONS
WATCH DIALS SECURELY FIXED TO PLATE BY COUNTERSUNK HEAD BRASS SCREWS M3×6mm LONG WITH NUTS AND WASHERS
38
32
25
25
19
19
13
22
19
16
13
10
10
6
3
50
50
50
75
37·5
100
25
124
38
45°
SLOT
124
159
6
300
32
22
25
19
25
16
25
13
25
25
25
3
70
32
19
19
19
19
SLOT
ZINC PLATE 0·9mm THICK SECURED TO FRAME BY 24 CHEESE HEAD SCREWS M6×12mm LONG WITH NUTS AND WASHERS
38
150
HORIZONTAL AND PERPENDICULAR LINES PAINTED BLACK
750

All dimensions in millimetres.

NOTE 1 — Face of zinc plate to be dead black.

NOTE 2 — All corners and edges of perforations to be clearly cut.

NOTE 3 — To be set up at 90 m distance with sky background.

APPENDIX F

(*Clause* 4.1.6)

METHOD OF DETERMINING RESOLVING POWER OF A TELESCOPE

F-1. An object screen on which two parallel lines are marked at a distance d apart, is mounted on a rotating table having circular graduations and placed at a distance D from the telescope. The object is placed normally so that the two lines subtend the maximum possible angle in the field of the telescope. The table is then rotated, when the two lines shall appear to come closer and closer until these are resolved. If the angle through which the table has been turned is θ, the resolving power of the telescope is given by $\frac{d. \cos \theta}{D}$.

APPENDIX G

(*Clause* 4.1.7)

METHOD OF MEASURING ANGULAR DISTORTION OF A TELESCOPE

G-1. A viewing telescope, provided with a crossline graticule is first focussed on a plumbline hung near a wall on which are marked two lines inclined at an angle of 30 minutes of arc with the plumbline on either side of it. The telescope is so adjusted that the vertical crossline coincides with the image of the plumbline. The telescope to be tested is then introduced between plumbline and the viewing telescope with its objective facing the plumbline. Observing through the viewing telescope, the image of the plumbline is now refocussed by adjusting the telescope under test.

G-2. The image of the plumbline shall remain in coincidence with vertical crossline within the limits of the two lines on either side of the plumbline.

APPENDIX H

(*Clause* 4.1.8)

METHOD OF TESTING ACCURACY OF DIOPTRIC SCALE

H-1. An auxiliary telescope is first focussed on the graticule of a collimator accurately adjusted for parallel light. The telescope under test is then placed between the collimator and the auxiliary telescope with its eyepiece towards the auxiliary telescope. The eyepiece of the telescope under test is set at zero dioptric marking. The graticule of the collimator shall then remain in focus. If it is out of focus, it shall be brought to focus by introducing a suitable standard dioptric lens in front of the eyepiece. The dioptric value of the standard lens is a measure of the inaccuracy of the zero dioptric setting. Inaccuracy at other dioptric markings is similarly determined.

APPENDIX J

(*Clause* 4.2.2)

METHOD OF MEASURING MAGNIFICATION OF A MICROSCOPE

J-1. The microscope is focussed on a stage micrometer or a graticule plate having two parallel lines of known separation placed on the stage of the microscope. The eyepiece of the microscope is removed after focussing; and the image of the object placed on the stage is measured by a micrometer eyepiece or a travelling microscope. The ratio of the distance between the image as measured to the actual distance gives the magnification of the object glass (for that tube length).

APPENDIX K

(*Clause* 4.2.4)

METHOD OF MEASURING RESOLVING POWER OF A MICROSCOPE OBJECTIVE

K-1. The objective under test is fitted to a microscope having an illuminator plate of good optical quality at the location shown in Fig. 3. It is focussed on a slide on which a silvered cover glass has been cemented. A graticule (having 24 to 28 lines per millimetre) fitted on a graduated turn-table and illuminated by a pointolite lamp. A condensing lens is so placed that its reduced image is formed on the plane of the silvered undersurface of the cover glass. This serves as an object for the lens under test. While observing the image of this, the grating on the turn-table is rotated until the lines are resolved. If the angle through which the grating has turned from its normal position is θ, and d is the interval between the lines in the object plane when the grating is normal to the optical axis, the minimum interval which the lens may resolve is $d . \cos \theta$.

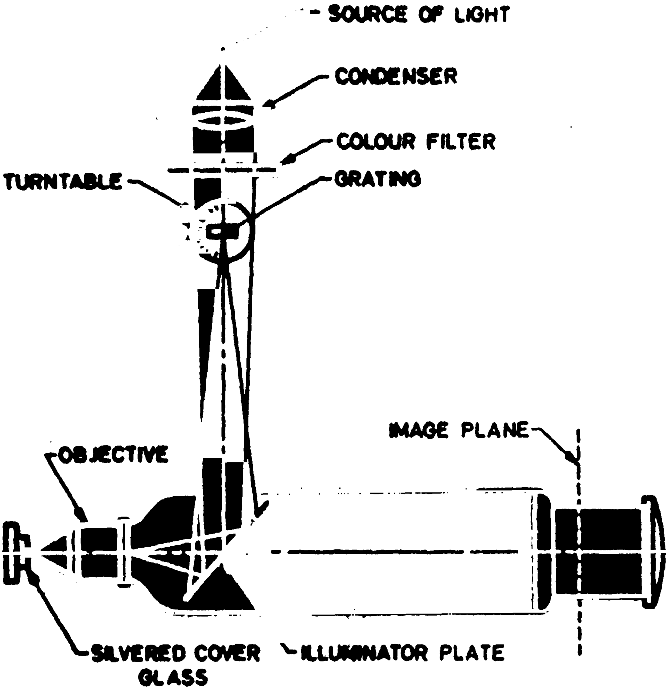


FIG. 3 APPARATUS FOR MEASUREMENT OF RESOLVING POWER OF A MICROSCOPE OBJECTIVE

APPENDIX L

(*Clause* 4.3.3)

METHOD OF MEASUREMENT OF EQUIVALENT FOCAL LENGTH OF CAMERA LENS

L-1. To measure the equivalent focal length of a camera lens a photographic plate is placed in the focal plane of the image space. A collimator and graticule may conveniently be used to provide an infinitely distant object point, but the collimator used should be of such a quality that it introduces no appreciable reduction of the definition of the lens under test. Exposures are made with the beam of light from the collimator directed along the axis of the lens and at a series of angles α_1, α_2, etc. On the resultant negative, measurements are made of the distances h_1, h_2, etc, of the images corresponding to the angles α_1, α_2, etc, from the axial image and the quotients $h_1/\tan \alpha_1$, $h_2/\tan \alpha_2$, etc, are calculated. The limiting value of this quotient, as α approaches zero, is the equivalent focal length.

APPENDIX M

(*Clause* 4.3.5)

METHOD FOR MEASUREMENT OF MAXIMUM APERTURE AND *f*-NUMBERS OF A CAMERA

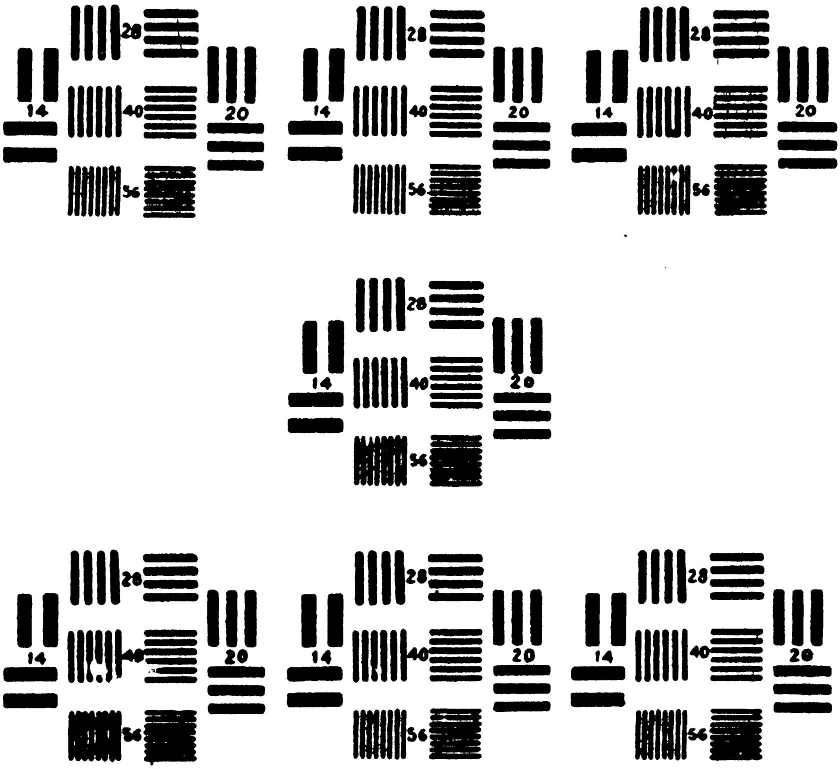
M-1. The entrance pupil of the photographic objective corresponding to any stop size shall be measured using a travelling microscope of low power (10× to 20×) having adequate travel and working distance. The diameter of the entrance pupil, which is the apparent image of the stop, gives the effective aperture.

M-1.1 The ratio of the equivalent focal length of the objective to the diameter of the effective aperture gives the *f*-number.

APPENDIX N

(*Clause* 4.4.6)

TEST CHART FOR RESOLVING POWER OF PROJECTORS



NOTE — The numbers in the chart between two similar patterns represent lines per millimetre. The distance between the two neighbouring patterns is not very critical and should be adjusted after considering the size of the object and the field of view of the lens.

APPENDIX P

(*Clause* 4.4.8)

METHOD OF MEASURING UNIFORMITY OF SCREEN ILLUMINATION

P-1. The projector shall be focussed on the film plane and illumination shall then be measured at a screen not less than 100 cm wide. Measurement of illumination shall be made with a photo-electric cell at the centre and at four points in the corners located one-twentieth of the screen width from the top or bottom edge and at the same distance from the side edges of the screen. The average illumination at the four corner points shall be computed, and any objectionable bands or patches differing in colour or brightness from adjacent parts of the screen shall be noted. This test shall be made with six new filament lamps selected at random (both 750-Watt and 1 000-Watt lamps shall be used in this test). During the entire test, a light meter utilizing the same photo-electric cell shall be employed.

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Alteration

(*Page 20, Appendix J, title*) - Substitute the following for the existing title:

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